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Sebih et al.

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(54) **INSTANCE USAGE FACILITATING SYSTEM**

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(51) **Int. Cl.**

H04L 12/24	(2006.01)
H04L 12/58	(2006.01)
H04L 29/08	(2006.01)
G06N 20/00	(2019.01)
H04L 12/26	(2006.01)

(52) **U.S. Cl.**

CPC ***H04L 41/14*** (2013.01); ***G06N 20/00*** (2019.01); ***H04L 41/16*** (2013.01); ***H04L 43/0817*** (2013.01); ***H04L 51/02*** (2013.01); ***H04L 67/10*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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(57) **ABSTRACT**

An object of the invention is to provide an instance usage facilitating system that finds an idle instance and makes the instance usable promptly and certainly. An instance usage facilitating system of the present invention is a system that detects an idle instance from among plural instances and makes the instance usable and includes a metrics acquisition unit, an instance selecting unit which selects an instance whose operating status should be inquired from among instances whose operating status is unknown, an inquiry unit which makes an inquiry of a user about the operating status of an instance and attaches a label indicating any of active, idle, and unknown statuses to the instance, an instance usage enabling unit which enables usage of an idle instance among labeled instances, and a machine learning unit which performs machine learning to determine the operating status of a new instance, using acquired metrics and labels.

4 Claims, 11 Drawing Sheets

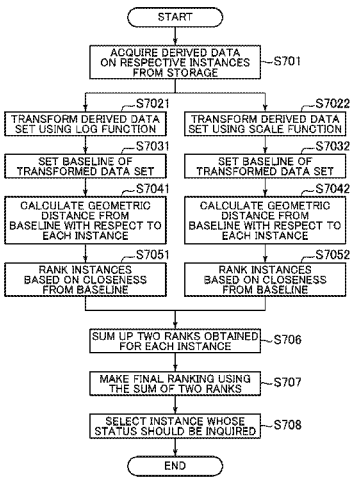


FIG. 1

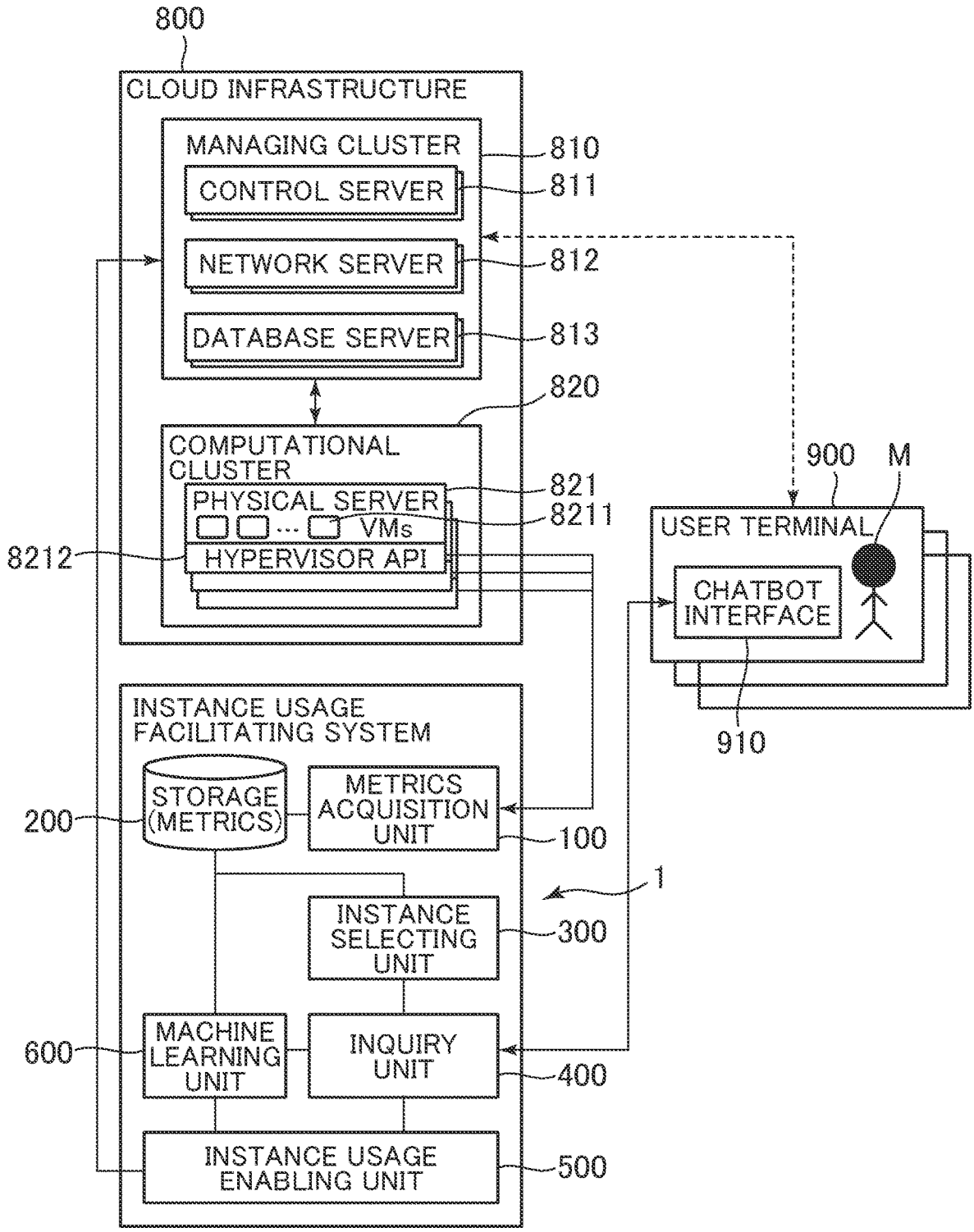

800
CLOUD INFRASTRUCTURE
MANAGING CLUSTER
810
CONTROL SERVER
811
NETWORK SERVER
812
DATABASE SERVER
813
820
COMPUTATIONAL CLUSTER
PHYSICAL SERVER
821
VMs
8211
8212
HYPERVISOR API
900
M
USER TERMINAL
CHATBOT INTERFACE
910
INSTANCE USAGE FACILITATING SYSTEM
STORAGE (METRICS)
200
METRICS ACQUISITION UNIT
100
1
INSTANCE SELECTING UNIT
300
MACHINE LEARNING UNIT
600
INQUIRY UNIT
400
INSTANCE USAGE ENABLING UNIT
500

FIG. 2

INSTANCE ID	SAMPLE DATE	CPU TIME	MEM UNUSED	RESIDENT MEM	DISK WRITE BYTES	DISK READ BYES	DISK WRITE I/O	DISK READ I/O	PACKET TRANSMIT BYTES	PACKET RECEIVE BYTES	PACKET TRANSMIT PACKETS	PACKET RECEIVE PACKETS
A	March 23rd 2017, 21:42:00.000	770	50	49	80	0	14	0	15916	18360	166	166
B	March 23rd 2017, 21:42:00.000	111750	27	100	50179	328	4671	25	17976	71864	230	1040
C	March 23rd 2017, 21:42:00.000	3060	7	69	303	0	46	0	1146	1482	17	25
D	March 23rd 2017, 21:42:00.000	23310	59	96	178	0	90	0	7212944	5779460	41185	44714
A	March 23rd 2017, 21:47:00.000	830	50	49	71	0	60	0	1684	34795	29	367
E	March 23rd 2017, 21:47:00.000	92187	49	76	22	0	18	0	138	331	7	17

FIG. 3A

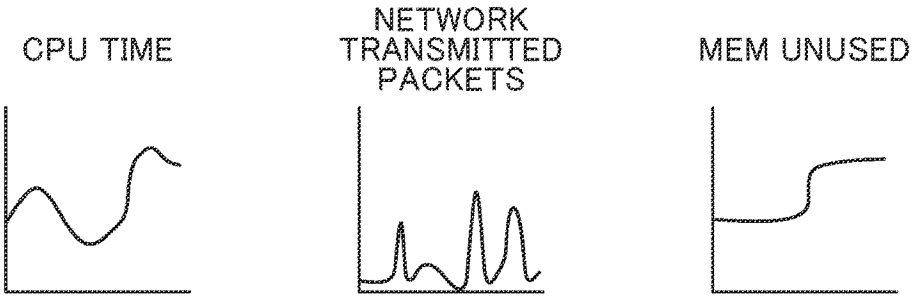


FIG. 3B

INSTANCE ID		1st DECILE	2st DECILE	4st DECILE	MEDIAN	MEAN	6th DECILE	7th DECILE	8th DECILE	9th DECILE	95th PERCENTILE	99th PERCENTILE	STANDARD DEVIATION
A	CPU TIME												
A	NETWORK TRANSMITTED PACKETS												
A	MEM UNUSED												

FIG. 3C

INSTANCE ID	CPU TIME 1st DECILE	. . .	CPU TIME STANDARD DEVIATION	NETWORK TRANSMITTED PACKETS 1st DECILE	. . .	NETWORK TRANSMITTED PACKETS STANDARD DEVIATION	MEM UNUSED 1st DECILE	. . .	MEM UNUSED STANDARD DEVIATION
A									

FIG. 4

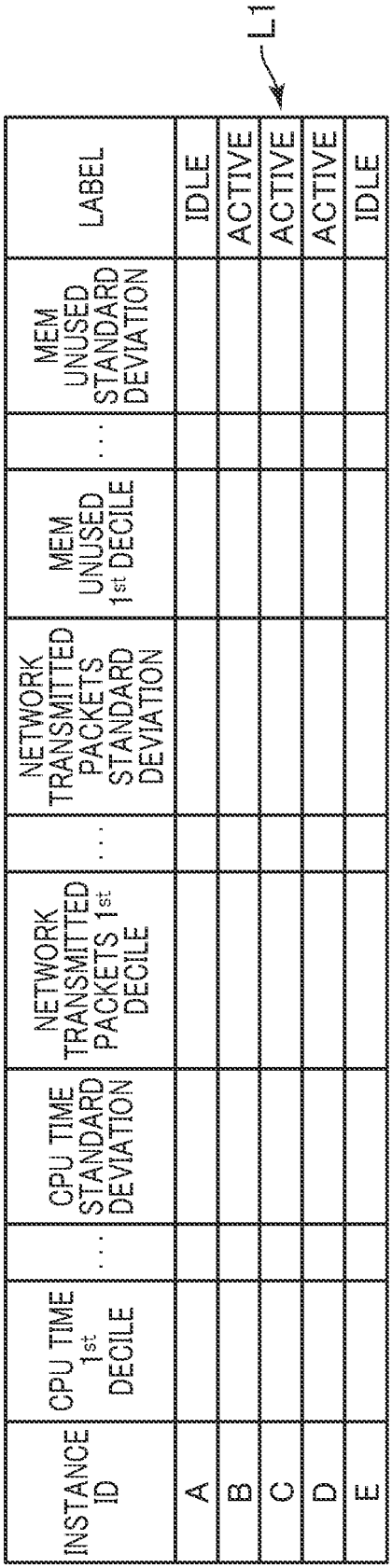

L1
INSTANCE ID
CPU TIME 1st DECILE
...
CPU TIME STANDARD DEVIATION
NETWORK TRANSMITTED PACKETS 1st DECILE
...
NETWORK TRANSMITTED PACKETS STANDARD DEVIATION
MEM UNUSED 1st DECILE
...
MEM UNUSED STANDARD DEVIATION
LABEL
A
IDLE
B
ACTIVE
C
ACTIVE
D
ACTIVE
E
IDLE

FIG. 5

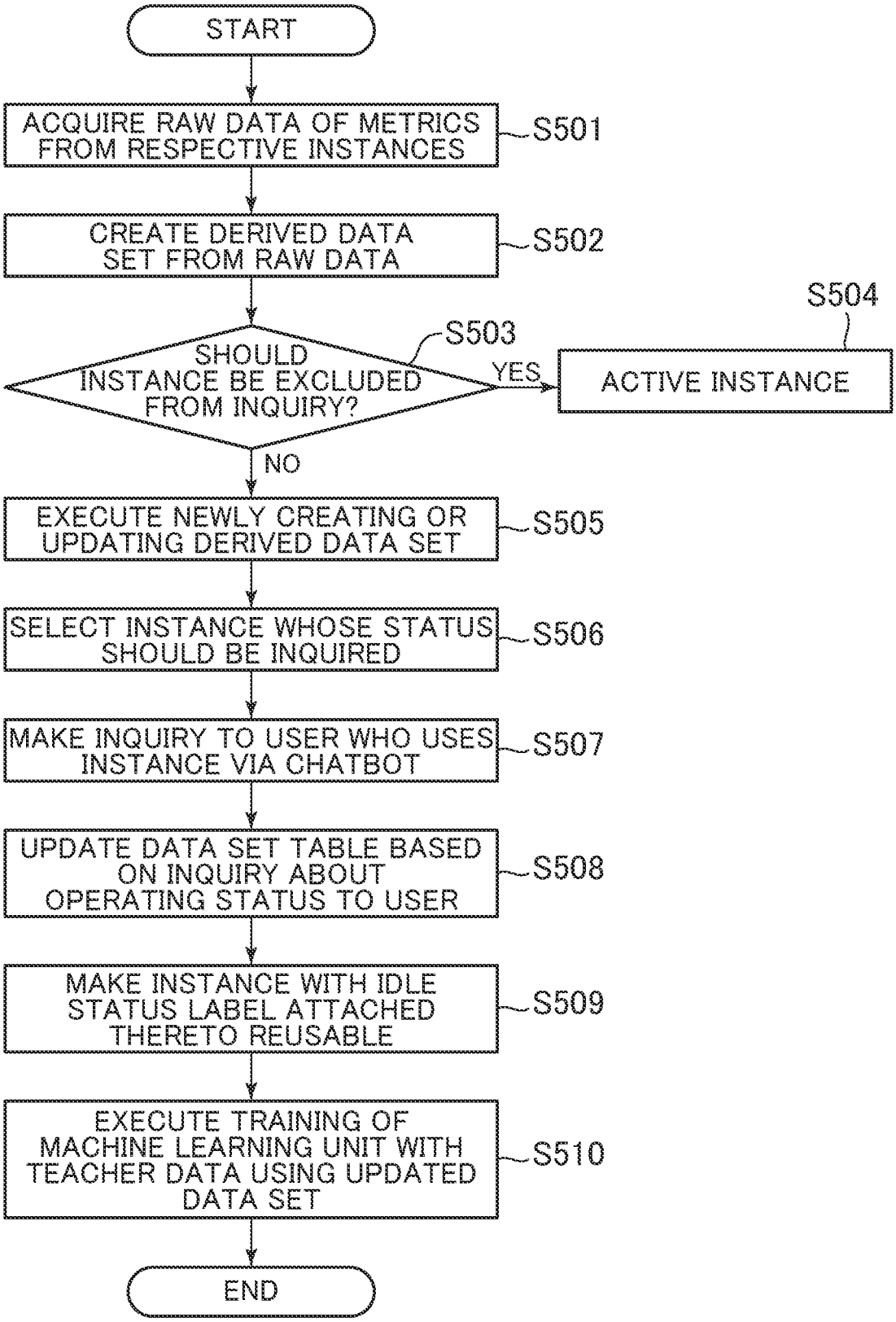

START
ACQUIRE RAW DATA OF METRICS FROM RESPECTIVE INSTANCES
S501
CREATE DERIVED DATA SET FROM RAW DATA
S502
S503
SHOULD INSTANCE BE EXCLUDED FROM INQUIRY?
YES
S504
ACTIVE INSTANCE
NO
EXECUTE NEWLY CREATING OR UPDATING DERIVED DATA SET
S505
SELECT INSTANCE WHOSE STATUS SHOULD BE INQUIRED
S506
MAKE INQUIRY TO USER WHO USES INSTANCE VIA CHATBOT
S507
UPDATE DATA SET TABLE BASED ON INQUIRY ABOUT OPERATING STATUS TO USER
S508
MAKE INSTANCE WITH IDLE STATUS LABEL ATTACHED THERETO REUSABLE
S509
EXECUTE TRAINING OF MACHINE LEARNING UNIT WITH TEACHER DATA USING UPDATED DATA SET
S510
END

FIG. 6

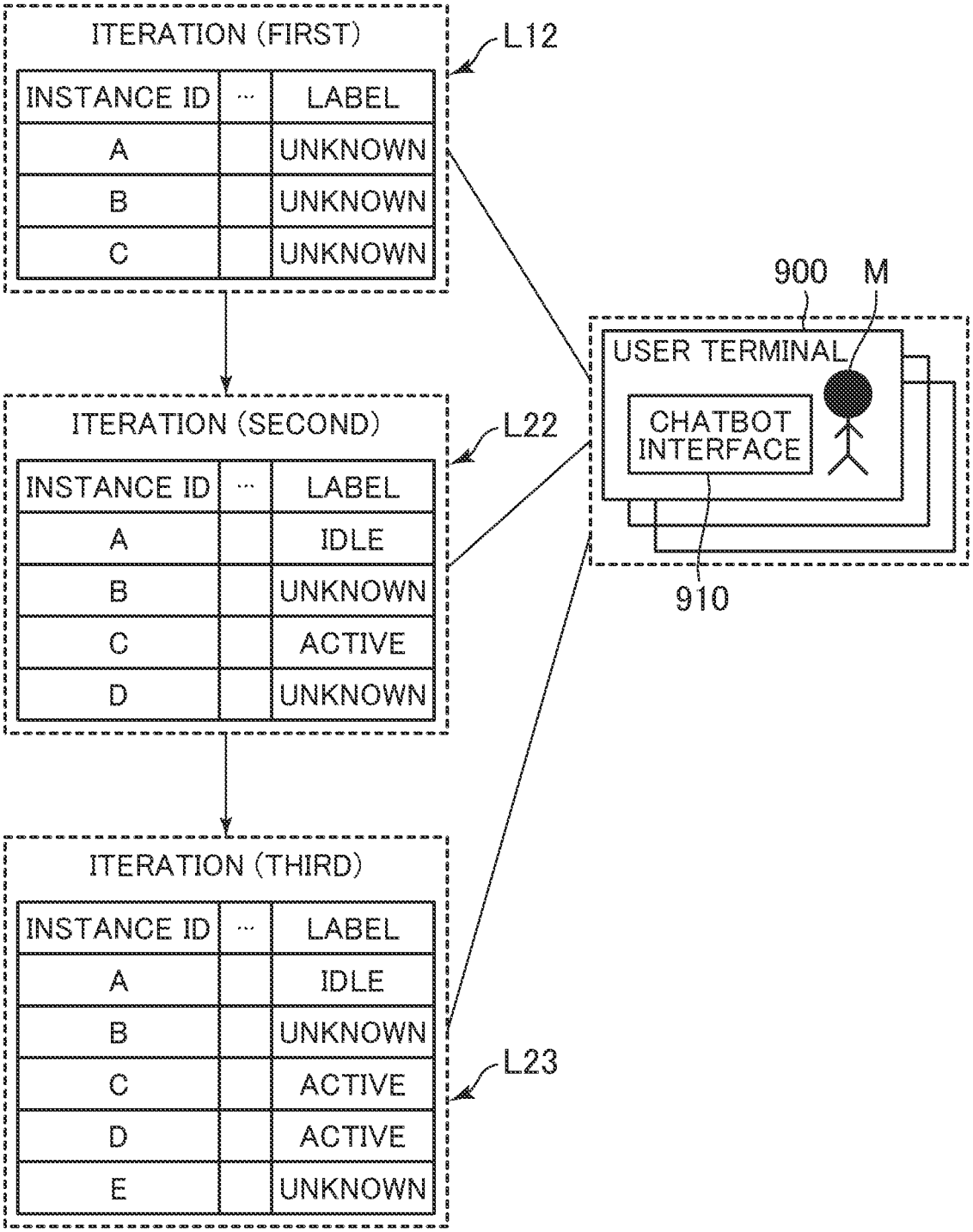

ITERATION (FIRST)
INSTANCE ID
···
LABEL
A
UNKNOWN
B
UNKNOWN
C
UNKNOWN
L12
ITERATION (SECOND)
INSTANCE ID
···
LABEL
A
IDLE
B
UNKNOWN
C
ACTIVE
D
UNKNOWN
L22
ITERATION (THIRD)
INSTANCE ID
···
LABEL
A
IDLE
B
UNKNOWN
C
ACTIVE
D
ACTIVE
E
UNKNOWN
L23
900
M
USER TERMINAL
CHATBOT INTERFACE
910

FIG. 7

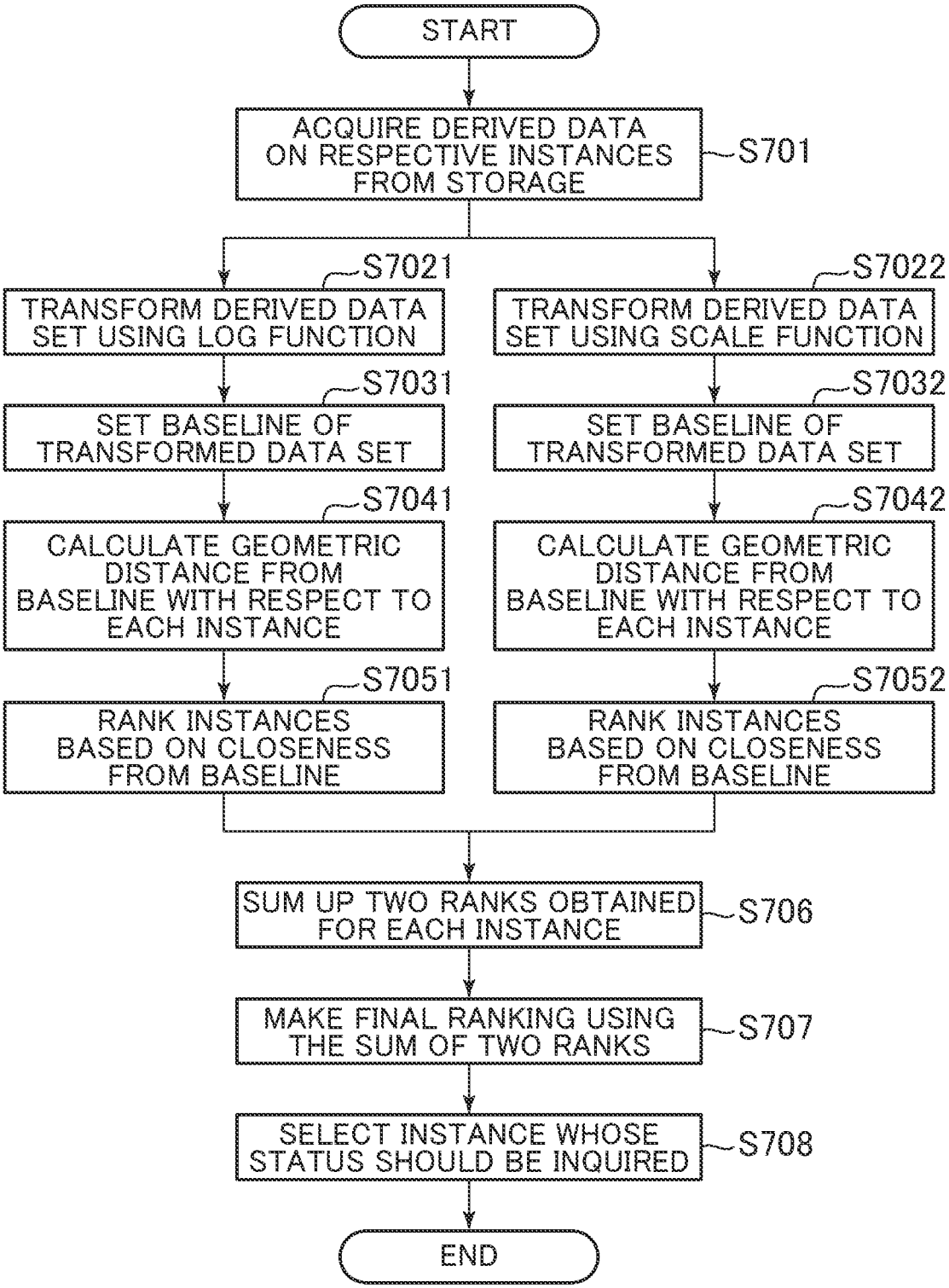

START
ACQUIRE DERIVED DATA ON RESPECTIVE INSTANCES FROM STORAGE
S701
S7021
TRANSFORM DERIVED DATA SET USING LOG FUNCTION
S7022
TRANSFORM DERIVED DATA SET USING SCALE FUNCTION
S7031
SET BASELINE OF TRANSFORMED DATA SET
S7032
SET BASELINE OF TRANSFORMED DATA SET
S7041
CALCULATE GEOMETRIC DISTANCE FROM BASELINE WITH RESPECT TO EACH INSTANCE
S7042
CALCULATE GEOMETRIC DISTANCE FROM BASELINE WITH RESPECT TO EACH INSTANCE
S7051
RANK INSTANCES BASED ON CLOSENESS FROM BASELINE
S7052
RANK INSTANCES BASED ON CLOSENESS FROM BASELINE
SUM UP TWO RANKS OBTAINED FOR EACH INSTANCE
S706
MAKE FINAL RANKING USING THE SUM OF TWO RANKS
S707
SELECT INSTANCE WHOSE STATUS SHOULD BE INQUIRED
S708
END

FIG. 8A

L31

INSTANCE ID	LABEL	IS BASELINE	CPU	MEM	DISK	NETWORK
A	IDLE	YES				
B	UNKNOWN	NO				
C	UNKNOWN	NO				
D	UNKNOWN	NO				
E	UNKNOWN	YES				

FIG. 8B

L32

INSTANCE ID	LABEL	IS BASELINE	CPU	MEM	DISK	NETWORK
A	IDLE	YES	LOG (VALUE)			
B	UNKNOWN	NO				
C	UNKNOWN	NO				
D	UNKNOWN	NO				
E	UNKNOWN	YES				

FIG. 8C

L33

INSTANCE ID	LABEL	IS BASELINE	CPU	MEM	DISK	NETWORK
A	IDLE	YES	(VALUE−AVG) / STDEV			
B	UNKNOWN	NO				
C	UNKNOWN	NO				
D	UNKNOWN	NO				
E	UNKNOWN	YES				

FIG. 8D

L34

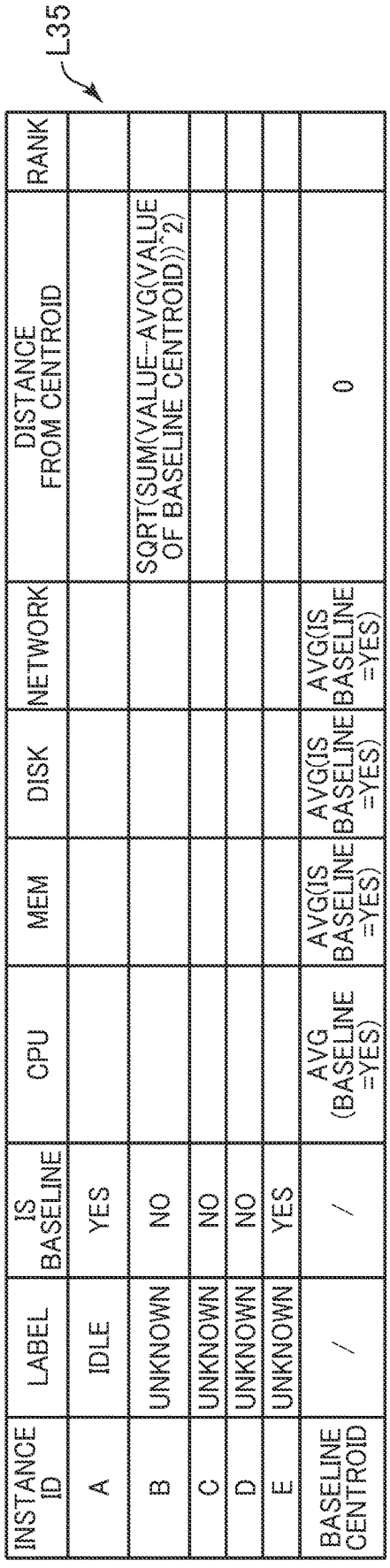
INSTANCE ID	LABEL	IS BASELINE	CPU	MEM	DISK	NETWORK
A	IDLE	YES				
B	UNKNOWN	NO				
C	UNKNOWN	NO				
D	UNKNOWN	NO				
E	UNKNOWN	YES				
BASELINE CENTROID	/	/	AVG (BASELINE =YES)	AVG(IS BASELINE =YES)	AVG(IS BASELINE =YES)	AVG(IS BASELINE =YES)

FIG. 8E

L35

INSTANCE ID	LABEL	IS BASELINE	CPU	MEM	DISK	NETWORK	DISTANCE FROM CENTROID
A	IDLE	YES					/
B	UNKNOWN	NO					SQRT(SUM(VALUE−AVG(VALUE OF BASELINE CENTROID))^2)
C	UNKNOWN	NO					
D	UNKNOWN	NO					
E	UNKNOWN	YES					/
BASELINE CENTROID	/	/	AVG (BASELINE =YES)	AVG(IS BASELINE =YES)	AVG(IS BASELINE =YES)	AVG(IS BASELINE =YES)	

FIG. 8F



INSTANCE ID	LABEL	IS BASELINE	CPU	MEM	DISK	NETWORK	DISTANCE FROM CENTROID	RANK
A	IDLE	YES						
B	UNKNOWN	NO					SQRT(SUM(VALUE-AVG(VALUE OF BASELINE CENTROID))^2)	
C	UNKNOWN	NO						
D	UNKNOWN	NO						
E	UNKNOWN	YES						
BASELINE CENTROID	/	/	AVG (BASELINE =YES)	AVG(IS BASELINE =YES)	AVG(IS BASELINE =YES)	AVG(IS BASELINE =YES)	0	

FIG. 8G

L37

INSTANCE ID	LABEL	IS BASELINE	CPU	MEM	DISK	NETWORK	LOG RANK	SCALE RANK	ADDITIVE RANK
A	IDLE	YES							LOG RANK +SCALE RANK
B	UNKNOWN	NO							
C	UNKNOWN	NO							
D	UNKNOWN	NO							
E	UNKNOWN	YES							

INSTANCE USAGE FACILITATING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

The present application claims priority from Japanese application JP 2017-222764, filed on Nov. 20, 2017, the contents of which is hereby incorporated by reference into this application.

BACKGROUND

The present invention relates to an instance usage facilitating system.

In cloud computing which utilizes computer resources existing across a network and causes them to execute a large variety of computation, a large number of computer resources are sometimes allocated to some users. Some of these computer resources appear not to be used actually, even though only allocated.

In this situation, when a lot of users want to use computer resources, because such a large number of resources have already been allocated, though available resources exist, a shortage of resources that can be used may occur consequently and computation may not be performed efficiently.

In order to avoid a shortage of instances as computer resources in such a situation, a technical approach outlined below is proposed: after machine learning of, e.g., a mapping relation between metrics acquired from respective instances existing across a network and actual operating status of the instances, as teacher data, is carried out, by estimating the operating status of each instance using a machine learning method by which the foregoing learning has been done, the technical approach facilitates reuse of idle instances (refer to, e.g., Kee Kim, et al., 2006, A Supervised Learning Model for Identifying Inactive VMs in Private Cloud Data Centers. In Proceedings of the Industrial Track of the 17th International Middleware Conference (Middleware Industry '16). ACM.).

According to this technical approach, after sufficient machine learning is carried out, it is possible to find an idle instance from among plural instances with a high degree of accuracy and make the idle instance usable again and it is expected to avoid a shortage of instances in totality.

SUMMARY

Now, when the technical approach noted above is used, it is necessary that machine learning is carried out sufficiently beforehand to classify the operating status of instances with a high degree of accuracy. To carry out such machine learning, it is prerequisite that a sufficient number of teacher data (labels) for use in training exists in advance.

However, given that the hitherto known technical approach as noted above is used, it is difficult to prepare in advance labels on the scale of cloud computing and it is difficult on a realistic level to request all users to provide information to be used for labeling. Therefore, only introducing a machine learning method does not make it possible to detect idle instances with a high degree of accuracy and, consequently, it is hard to make unused instances usable early and certainly.

The present invention has been developed based on circumstances as noted above and an object of the invention resides in providing an instance usage facilitating system that enables it to find an idle instance and make the instance usable promptly and certainly even in a situation where there is no sufficiency of teacher data (labels) for machine learning.

The present invention concerns aspects as follows:

(1) An instance usage facilitating system that detects an idle instance from among a plurality of instances for use in a cloud infrastructure and makes the idle instance usable, the instance usage facilitating system including:

a metrics acquisition unit which acquires metrics of respective instances from the plurality of instances;

an instance selecting unit which selects an instance whose operating status should be inquired from among instances whose operating status is unknown among the plurality of instances;

an inquiry unit which makes an inquiry of a user about the operating status of an instance selected by the instance selecting unit and attaches a label indicating any of active, idle, and unknown statuses to the instance, based on a result of the inquiry;

an instance usage enabling unit which enables usage of an instance with an idle status label attached thereto among instances labeled by the inquiry unit; and

a machine learning unit which performs machine learning to determine the operating status of a new instance, using the metrics of respective instances acquired by the metrics acquisition unit and the labels of the respective instances attached by the inquiry unit.

(2) The instance usage facilitating system, as set forth in (1), wherein selecting an instance by the instance selecting unit, making an inquiry to a user and instance labeling by the inquiry unit, and enabling instance usage by the instance usage enabling unit are iteratively executed.

(3) The instance usage facilitating system, as set forth in (1) or (2), wherein the instance selecting unit selects an instance whose operating status should be inquired, using a heuristic algorithm.

(4) The instance usage facilitating system, as set forth in (3), wherein the heuristic algorithm is a combination of an algorithm using log transformation and an algorithm using scale transformation.

(5) The instance usage facilitating system, as set forth in any one of (1) thru (4), wherein the instance usage facilitating system is used under a multi-tenant cloud environment.

(6) The instance usage facilitating system, as set forth in any one of (1) thru (5), wherein the inquiry unit makes an inquiry about the operating status of an instance via a chatbot interface.

Now, "instances" mentioned herein means virtual computers (virtual machines (VMs)) which are built by software and activated on physical computers (physical servers). A "multi-tenant cloud environment" means a cloud computing environment including equipment, software, databases, etc. to be shared by plural companies (organizations). A "chatbot interface" means a simple man-machine interface that automatically sends an inquiry from the inquiry unit to a user and receives a reply from the user.

The present invention can provide an instance usage facilitating system that enables it to find an idle instance and make the instance usable promptly and certainly even in a situation where there is no sufficiency of teacher data (labels) for machine learning.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an overview block diagram depicting one embodiment of the present invention;

FIG. **2** is a diagram in a summary form representing one example of metrics information acquired by the system in FIG. **1**;

FIG. **3**A is a diagram in a summary form representing one example of metrics sorted by instance based on the metrics information as presented in FIG. **2**;

FIG. **3**B is a diagram in a summary form representing one example of metrics sorted by instance based on the metrics information as presented in FIG. **2**;

FIG. **3**C is a diagram in a summary form representing one example of derived data to which metrics information in FIG. **3**B is converted;

FIG. **4** is a diagram in a summary form representing one example of derived data, as presented in FIG. **3**C, associated with labels;

FIG. **5** is a block diagram in a summary form illustrating a processing flow in relation to FIG. **1**;

FIG. **6** is a diagram in a summary form representing examples of lists obtained by iteration of the processing flow, as illustrated in FIG. **5**;

FIG. **7** is a flowchart in a summary form illustrating one example of instance selection processing that is performed by the instance selecting unit, as presented in FIG. **1**;

FIG. **8**A is a diagram in a summary form representing a concrete example of processing performed by the instance selecting unit, the diagram presenting one example of a list;

FIG. **8**B is a diagram in a summary form representing a concrete example of processing performed by the instance selecting unit, the diagram presenting one example of a list;

FIG. **8**C is a diagram in a summary form representing a concrete example of processing performed by the instance selecting unit, the diagram presenting one example of a list;

FIG. **8**D is a diagram in a summary form representing a concrete example of processing performed by the instance selecting unit, the diagram presenting one example of a list;

FIG. **8**E is a diagram in a summary form representing a concrete example of processing performed by the instance selecting unit, the diagram presenting one example of a list;

FIG. **8**F is a diagram in a summary form representing a concrete example of processing performed by the instance selecting unit, the diagram presenting one example of a list; and

FIG. **8**G is a diagram in a summary form representing a concrete example of processing performed by the instance selecting unit, the diagram presenting one example of a list.

DETAILED DESCRIPTION

An instance usage facilitating system of the present invention is the instance usage facilitating system that detects an idle instance from among plural instances for use in a cloud infrastructure and makes the idle instance usable. The instance usage facilitating system is characterized by including a metrics acquisition unit which acquires metrics of respective instances from the plural instances; an instance selecting unit which selects an instance whose operating status should be inquired from among instances whose operating status is unknown among the plural instances; an inquiry unit which makes an inquiry of a user about the operating status of an instance selected by the instance selecting unit and attaches a label indicating any of active, idle, and unknown statuses to the instance, based on a result of the inquiry; an instance usage enabling unit which enables usage of an instance with an idle status label attached thereto among instances labeled by the inquiry unit; and a machine learning unit which performs machine learning to determine the operating status of a new instance, using the metrics of respective instances acquired by the metrics acquisition unit and the labels of the respective instances attached by the inquiry unit.

The instance usage facilitating system **1** is applied to, inter alia, a cloud environment where a cloud infrastructure **800** is build, as depicted in FIG. **1**, where, for example, a user M may connect to an Infrastructure as a Service (IaaS) via a user terminal **900** and get access to an instance (a virtual machine **8211**) in a physical server **821** through a hypervisor API **8212**, thereby allowing the user to use the instance.

In the following, one embodiment of the present invention will be described with reference to the drawings; however, the present invention should not be construed to be limited to the embodiment whose details are depicted in the drawings.

FIG. **1** is an overview block diagram depicting one embodiment of the present invention. As depicted in FIG. **1**, the instance usage facilitating system **1** is generally comprised of a metrics acquisition unit **100**, storage **200**, an instance selecting unit **300**, an inquiry unit **400**, an instance usage enabling unit **500**, and a machine learning unit **600**.

The metrics acquisition unit **100** acquires metrics (e.g., CPU occupation time, unused memory, amounts of packets for communication, etc.) from plural instances. In particular, from respective instances (virtual machines) **8211**) in physical servers **821** in a computational cluster **820**, e.g., as depicted in FIG. **1**, the metrics acquisition unit **100** acquires the metrics of respective instances via the API (Application Program Interface) **8212** and stores the thus acquired metrics into the storage **200**. Now, timing to acquire metrics information may be either periodic (at intervals of five minutes or other period of time) or non-period; however, it is preferable that the timing should be determined to allow an inquiry to be performed by the inquiry unit **400**, which will be described later, during an interval.

Now, FIG. **2** is a diagram in a summary form representing one example of metrics information acquired by the system in FIG. **1**. Plural instances are assigned an instance ID to identify each instance and the metrics information is associated with this instance ID. Now, when operation of an instance halts or stops, no metrics information is issued from the instance during the halt or the like.

The instance selecting unit **300** selects an instance whose operating status should be inquired from among instances whose operating status is unknown among the plural instances. Instances that may be selected by the instance selecting unit **300** are typically a subset of the instances whose operating status is unknown from a perspective of reducing the load of the inquiry unit **400** in performing an inquiry operation; however, those instances may be all of the instances whose operating status is unknown.

As for a way in which the instance selecting unit **300** selects an instance, it is preferable to select an instance whose operating status should be inquired, using a heuristic algorithm to which no limitation is intended. Particular examples of the heuristic algorithm are an algorithm with log transformation, an algorithm with scale conversion, an algorithm combining the algorithm with log transformation and the algorithm with scale transformation, etc. Among these, the algorithm combining the algorithm with log transformation and the algorithm with scale transformation, which will be described later, is preferable as the heuristic algorithm.

As described above, the instance selecting unit **300** uses a heuristic algorithm in selecting an instance. This enables the instance usage facilitating system **1** to promptly select an instance that is likely to be idle from among instances whose

operating status is unknown. Particularly, use of the algorithm combining the algorithm with log transformation and the algorithm with scale transformation as the heuristic algorithm allows for selecting an a comparatively high ranked algorithm in each algorithm; therefore, it is possible to make an selection using the heuristic algorithm more accurately.

The inquiry unit **400** makes an inquiry of a user M about the operating status of an instance selected by the instance selecting unit **300** and attaches a label indicating any of active, idle, and unknown statuses to the instance, based on a result of the inquiry. In particular, the inquiry unit **400** is equipped with, e.g., a user notification module **410** which transmits an inquiry about usage status of instances maintained by the user to a user terminal **900** and receives an answer to the inquiry from the user terminal **900**, registers the answer obtained from the user by this inquiry into a list L**1** as teacher data (labels), and stores this data in association with metrics information for each instance into the storage **200** (e.g., see FIG. **4**).

Now, it is preferable that, via the chatbot interface **910** that a user terminal **900** has, the inquiry unit **400** makes an inquiry of the user M about the operating status of an instance that is subject to inquiry. As the chatbot interface **910**, e.g., a publicly known chatbot interface or the like can be used. This enables it to make an inquiry about the operating status of an instance efficiently without consuming time.

Now, particular examples of a label indicating the operating status of an instance are a label (idle) indicating a true idle status, a label (active) indicating a non-idle status I, and a label (unknown) indicating that no answer is obtained from the user, etc.

The instance usage enabling unit **500** enables usage of an instance with an idle status label (idle) attached thereto among instances labeled by the inquiry unit **400**. In particular, the instance usage enabling unit **500**, for example, transmits instance ID information of an instance with an idle status label attached thereto to a managing cluster **810** in the cloud infrastructure **800**. Then, the relevant instance (virtual machine **8211**) in a physical server **821** is made free via a control server **811** in the managing cluster, thus making it transit into a newly usable status.

The machine learning unit **600** performs machine learning to determine the operating status of a new instance (whose operating status is unknown), using the metrics of respective instances acquired by the metrics acquisition unit **100** and the labels of the respective instances attached by the inquiry unit **400**. A way of learning that is performed by the machine learning unit **600** is non-limiting; for example, a publicly known technique or the like, such as deep machine learning can be used.

Here, it is preferable that the instance usage facilitating system **1** is a system in which the following are iteratively executed: selecting an instance by the instance selecting unit **300**, making an inquiry to a user M and instance labeling by the inquiry unit **400**, and enabling instance usage by the instance usage enabling unit **500**. In particular, using an original list (see a list L**21** at "iteration (first)" in FIG. **6**) in which, for example, the operating statuses of instances A, B, and C are registered, the instance usage facilitating system **1** performs processing to update the original list L**21** by updating the operating statuses based on results of inquiries about the "unknown" instances A, B, and C and adding an "unknown" instance D newly selected by the instance selecting unit **300** (see a list L**22** at "iteration (second)" in FIG. **6**); then, the system updates the list **22** by performing similar processing successively (see a list L**23** at "iteration (third)" in FIG. **6**). Now, the above iteration can be performed successively, though not depicted.

By configuring the system such that the instance selecting unit **300** and other units perform processing iteratively, the number of instances whose operating status is known can be increased gradually and it is possible to make unknown instances usable more efficiently, while restraining the load of inquiry (and the load on users M inquired).

Now, each processing that is performed by the metrics acquisition unit **100**, instance selecting unit **300**, inquiry unit **400**, instance usage enabling unit **500**, and machine learning unit **600**, as described above, can be implemented in such a way that hardware, which is not depicted, including a central processing unit (CPU), a memory, and a storage device as well as a bus or the like interconnecting them is used and a predefined computer program is run on the hardware.

Then, descriptions are provided about one example of a processing flow using the instance usage facilitating system **1**. FIG. **5** is a block diagram in a summary form illustrating the processing flow of the instance usage facilitating system **1**. In the instance usage facilitating system **1**, as illustrated in FIG. **5**, first, the metrics acquisition unit **100** acquires instance's metrics information (raw data) from respective instances periodically or non-periodically (step S**501**). The above raw data, for example, includes time-series data of CPU operating time, amounts of packets for communication, unused memory amount, etc. at acquisition time (time stamp), acquired for instances which are identified by an instance ID (see FIG. **2**, FIG. **3**A, and FIG. **3**B).

Next, the metrics acquisition unit **100** converts the metrics information (raw data) collected at step S**501** to derived data (step S**502**). The derived data is comprised of a data set of a series of metrics collected for one instance which is identified by an instance ID and includes metrics acquired at all times. This derived data constitutes one entry for each instance and each entry is registered into a list.

Next, the instance selecting unit **300** determines to exclude an instance whose operating status should be inquired among instances for which derived data is created (step S**503**) and deselects the instance determined to be excluded (step S**504**). A particular example of this instance that is deselected by the instance selecting unit **300** is an instance with a label (active) attached thereto indicating a non-idle status.

Next, the metrics acquisition unit **100** stores the derived data on instances other than the instance(s) excluded at step S**503** into the storage **200** as new data or updated data (step S**505**).

Next, the instance selecting unit **300** selects an instance whose operation status should be inquired (step S**506**). A way of selection that is used in this step is, for example, a heuristic algorithm or the like, such as an algorithm combining a log function and a scale function, which will be described later.

Next, the inquiry unit **400** makes an inquiry of a user M about the operating status of the instance selected by the instance selecting unit **300** via, e.g., the chatbot interface **910** (step S**507**). Then, an answer from the user M is classified with any of a true idle status, a non-idle status, and no answer and, based on the above answer, the inquiry unit **400** newly registers a label into a list L**1** as presented in FIG. **4** or updates the contents of the list (step S**508**).

Next, the instance usage enabling unit **500** performs processing to enable it to reuse an instance to which an idle status label is attached by the inquiry unit **400** (step S**509**). In particular, the instance usage enabling unit **500**, for

example, transmits an instance ID and a signal indicating that the instance with this instance ID is reusable to a control server **811** in the managing cluster **810** presented in FIG. **1** and the above instance is made reusable via the control server **811**, a network server **812**, a database server **813**, etc.

Next, the machine learning unit **600** performs machine learning to determine the operating status of a new instance, using the metrics of respective instances acquired previously and the labels attached to the instances (step S**510**). Next, after the execution of step S**510**, a return is made to step S**501**, as required, and the foregoing steps S**501** to S**510** are executed iteratively.

Then, descriptions are provided in greater detail as to an instance selection that is made by the instance selecting unit **300**, described previously, taking a heuristic algorithm combining an algorithm using log transformation and an algorithm using scale transformation as an example. FIG. **7** is a flowchart in a summary form illustrating one example of instance selection processing that is performed by the instance selecting unit **300** of the instance usage facilitating system **1**. FIGS. **8**A to **8**G are diagrams in a summary form representing a concrete example of the above processing.

The present algorithm first acquires a list L**31** in which derived data on respective instances is registered from the storage **200** (step S**701**). Then, using the acquired list L**31**, the algorithm performs a log transformation of data in this list L**31** (in particular, applying a "loglp" function) (see a list L**32** in FIG. **8**B) (step S**7021**) and, besides, performs a scale transformation of the above derived data (the transformation is made by centering respective values so that their average value will be a median and dividing them by standard deviation) (see a list L**33** in FIG. **8**C) (step S**7022**).

Next, the algorithm calculates average values of metrics with regard to a baseline instance that has been set in an idle status intentionally by a cloud administrator (see a list L**34** in FIG. **8**D) (step S**7031**). After that, the algorithm calculates a geometric distance of the metrics on the respective instances from the above average values (see a list L**35** in FIG. **8**E) (step S**7041**). Next, based on this geometric distance, the algorithm ranks each one of the derived data based on the foregoing log transformation (see a list L**36** in FIG. **8**F) (step S**7051**). Now, because steps S**7032**, S**7042**, and S**7052** with regard to scale transformation in FIG. **7** are the same as the above-described steps S**7031**, S**7041**, and S**7051**, their description and reference to the figures are omitted.

Next, the algorithm sums up two ranks by log transformation and scale transformation obtained for each derived data (step S**706**), determines a final ranking by the resulting sum and registers it (see a list L**37** in FIG. **8**G), and selects an instance whose status should be inquired, based on this final ranking (step S**708**).

Now, the more accurate the heuristic algorithm, the higher will be likelihood that a selected instance is idle. In consequence, it is possible to facilitate making instances usable. Now, accuracy is 80% on average when processing in the steps S**701** to S**708** is repeated several times.

Now, it is preferable that the instance usage facilitating system **1** is used under a multi-tenant cloud environment. So, the use of the instance usage facilitating system **1** under a multi-tenant cloud environment makes it possible to make unused instances usable efficiently even under a variety of cloud environments where, for example, multiple operating systems (OS) that a physical server **821** controls coexist.

In addition, the instance usage facilitating system **1** is applicable to either of a public cloud infrastructure (which is built to make it possible to provide a cloud computing environment which is provided by a cloud provider or the like to many and unspecified users, inter alia, companies (organizations) across the Internet and a private cloud infrastructure (which is built exclusively for a single company (organization) using cloud technology); however, the system is preferably applicable to the private cloud infrastructure, because computational processing within the same company (organization) can be performed more efficiently, if the system is used in the private cloud infrastructure.

As per the foregoing, since the instance usage facilitating system **1** is configured as described hereinbefore, the system enables it to find idle instances and make them usable promptly and certainly even in a situation where there is no sufficiency of teacher data (labels) for machine learning and allows for efficient operation of the cloud structure **800** as a whole.

Now, the present invention is not limited to the configuration of the foregoing embodiment, but is encompassed by the scope of claims, and is intended to include all modifications within the meaning and scope equivalent to the scope of claims.

For instance, while the instance usage facilitating system is described in the foregoing embodiment such that, making an instance usable, which is performed by the instance usage enabling unit **500**, is performed for an instance to which an idle status label is attached based on an inquiry made by the inquiry unit **400**, an instance usage facilitating system may be such that the above instance usage enabling unit performs making an instance usable based on combination of information on the operating statuses of respective instances obtained by the inquiry unit and information on the operating statuses of respective instances determined using a result of machine learning by the machine learning unit, as described previously.

What is claimed is:

1. An instance usage facilitating system that detects an idle instance from among a plurality of instances for use in a cloud infrastructure and makes the idle instance usable, the instance usage facilitating system comprising:

a memory coupled to a processor, the memory storing instructions that when executed by the processor configure the processor to:

acquire metrics of respective instances from the plurality of instances;

select an instance, whose operating status is to be inquired, from among instances whose operating status is unknown among the plurality of instances based on a combination of a first algorithm using log transformation and a second algorithm using scale transformation, each of the first algorithm and the second algorithm performs processing including:

calculates average values of metrics with respect to a predetermined baseline instance that is in an idle status,

calculates a geometric distance of the metrics on the respective instances from the average values,

determine a first rank based on each of the metrics based on the processing of the first algorithm and determine a second rank based on the each of the metrics based on the processing of the second algorithm based on the respective geometric distances,

sum up the first rank and the second rank, determine a final ranking based on the sum, wherein the instance is selected based on the final raking;

inquire about the operating status of the selected and attach a label indicating a status of any of active, idle, and unknown to the selected instance, based on a result of the inquiry;

enable usage of an instance with an idle status label attached thereto among labeled instances; and

perform machine learning to determine the operating status of a new instance, using the metrics of respective instances and the labels of the respective instances.

2. The instance usage facilitating system according to claim **1**, wherein the processor is configured to periodically select the instance, inquire about the selected instance, label the instance and enable instance usage.

3. The instance usage facilitating system according to claim **1**, wherein the instance usage facilitating system is used under a multi-tenant cloud environment.

4. The instance usage facilitating system according claim **1**, wherein the processor is configured to inquire about the selected instance via a chatbot interface.

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